

AE 422 Flight Propulsion I (071)

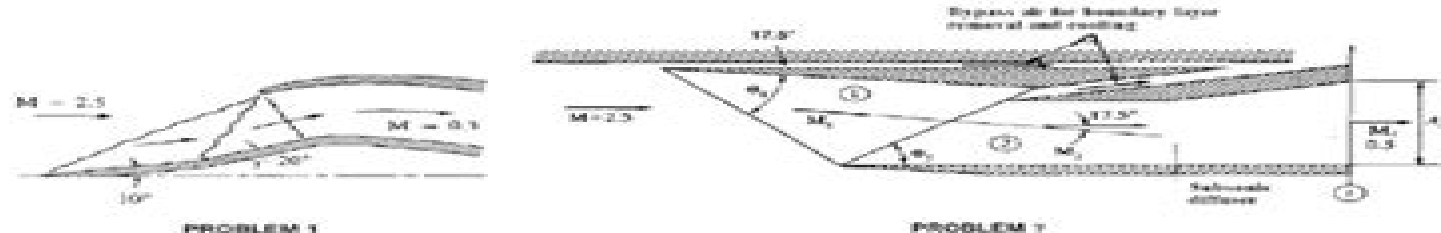
Homework No. 3

Assigned: 24-10-28H/05-11-07G

Due Date: 02-11-28H/12-11-07G

Problems 1, 7, 8, 15 of chapter 6

1. A two-dimensional or wedge-type diffuser consists of two external oblique shocks, a normal shock, and a subsonic internal section, as shown in the figure. Assuming no external losses other than shock losses, and assuming the subsonic section stagnation pressure loss is 3%, find the overall total pressure ratio at a flight Mach number of 2.5. Sketch the inlet shock system roughly to scale and label all angles.



7. A new supersonic passenger aircraft is being designed for flight Mach number 2.5 at an altitude where the ambient pressure and temperature are 9 kPa and 220 K, respectively. The engine inlet configuration shown below allows for double oblique shock deceleration followed by a zone of subsonic deceleration. The Mach number is 0.5 at the engine inlet plane (i). Losses in the subsonic diffuser are neglected. Determine:

- The Mach numbers M_1 and M_2 in the zones (1) and (2) shown on the drawing.
- the wave angles θ_1 and θ_2 , also shown on the drawing.
- the overall stagnation pressure ratio $p_{0i}/p_{0\infty}$.
- the overall static pressure ratio $p_i/p_{0\infty}$.
- the velocity ratio c_1/c_2 for the subsonic diffuser, and
- the cross-sectional area A_i (m²) at the engine inlet plane if the engine mass flow rate is 500 kg/s.

8. A ramjet engine is to fly at a Mach number of 4 in an atmosphere whose temperature is 223 K. At entrance to the burner, the Mach number of the flow is 0.3. Combustion in the burner (whose cross-sectional area is constant) may be represented approximately as heating of a perfect gas with constant specific heat ratio. At the exit from the burner the temperature of the gas is 2462 K. Neglecting frictional effects in the burner and considering the flow to be one-dimensional throughout, estimate the Mach number of the gas leaving the burner. Determine also the stagnation pressure loss due to heating (i.e., calculate the ratio of outlet and inlet stagnation pressures).

15. The hot gas supply to a propulsion nozzle is at a pressure of 55 kPa and a temperature of 800 K. The ambient pressure is 15 kPa. If the ratio of specific heats is 1.33, approximately constant, and the molecular weight of the mixture is 30, determine the ratio of gross thrusts for two cases:

- The nozzle is converging-diverging with the area ratio for correct expansion to ambient pressure.
 - The nozzle is converging only.
- What is the nozzle-exit-to-throat area ratio for case (a)? The gross thrust is the contribution to engine thrust made by the exhaust nozzle only.

Fundamentals Of Engineering Thermodynamics 7e Solution Manual

Efstathios Michaelides



Fundamentals Of Engineering Thermodynamics 7e Solution Manual:

Fundamentals of Engineering Thermodynamics Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey, 2010-12-07 This leading text in the field maintains its engaging readable style while presenting a broader range of applications that motivate engineers to learn the core thermodynamics concepts Two new coauthors help update the material and integrate engaging new problems Throughout the chapters they focus on the relevance of thermodynamics to modern engineering problems Many relevant engineering based situations are also presented to help engineers model and solve these problems

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